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**Before the**
**Federal Communications Commission**
**Washington, D.C. 20554**

**MM Docket No. 87-268**

In the Matter of

Advanced Television Systems and Their Impact on the Existing Television Broadcast Service — RM-5811

Review of Technical and Operational Requirements Part 73-E Television Broadcast Stations

Reevaluation of the UHF Television Channel and Distance Separation Requirements of Part 73 of the Commission's Rules

# COMMENTS OF NHK - THE JAPAN BROADCASTING CORPORATION

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## SUMMARY

Nippon Hoso Kyokai, "NHK" (The Japan Broadcasting Corporation) has spent 17 years in the development of high definition television (HDTV) and the MUSE (Multiple Sub-Nyguist Sampling Encoding) system to transmit HDTV via satellite. The MUSE system creates television pictures with the quality of 35mm film. The resulting clarity and reality of the television picture is quite extraordinary, rendering a high-level psychovisual effect. The MUSE-HDTV system has no competitors. It is the only true high definition television system available. It reflects quality in the highest sense.

MUSE-HDTV, however, is not compatible with today's standard television receivers (NTSC). However, an NTSC set can be made to receive MUSE-HDTV through the installation of a low-cost converter (less than $50.00). Moreover, when MUSE receivers come on the market, they will be able to display both MUSE and NTSC signals. To ease the transition to true HDTV, NHK suggests that the FCC consider the MUSE Family Systems, which includes ADTV--a wide screen, 6 MHz, NTSC-compatible system containing components of the MUSE system which enhances the quality of the picture. The ADTV system is suggested as a transitional terrestrial system

prior to the full implementation of HDTV over 9 MHz channels.

NHK has been the pioneer in the field of advanced television systems. It has cooperated in sharing its knowledge with others because NHK believes that it can make its greatest contribution by making available its technology. NHK plans to make the patents available for use by both domestic and foreign manufacturers in the fairest possible manner.

The emergence of this new technology will provide many benefits. Consumers, of course, will benefit from the availability of affordable television sets that show sharp, realistic, movie-quality pictures. But the technology also has applications in the film and medical industries, and will affect the computer industry.

Starting in 1990, the MUSE system will be appearing in homes in the United States, Canada and Japan. The display unit will permit input from laser videodiscs, videotape or a receiver. As noted, the receiver will be capable of receiving both MUSE and NTSC formats.

As consumers are able to watch some programs in MUSE and other programs in some NTSC variation, the difference in quality will undoubtedly cause consumers to prefer

MUSE programming. Those media which do not or cannot offer MUSE will suffer significant audience loss.

Broadcasters should be permitted to remain competitive by offering MUSE service to their communities. If a transition from NTSC to MUSE is planned now, while spectrum is available, the costs and difficulties of a gradual migration can be minimized and broadcasters will not find themselves shackled with an inferior system and the inability to find adequate spectrum to compete.

# COMMENTS OF NHK

## I. INTRODUCTION

Nippon Hoso Kyokai, "NHK" (The Japan Broadcasting Corporation) submits these Comments in response to the Federal Communications Commission's ("FCC" or "Commission") Notice of Inquiry ("Notice" or "NOI") in the above-captioned proceeding.*

The Commission's stated objective in opening a Notice of Inquiry is to develop a broad and detailed record concerning the emergence of advanced television systems ("ATV") and their relevance for off-air television broadcasting. In the NOI the Commission noted that the television technical standard devised in 1941 by the National Television Systems Committee (NTSC standard) reflects the technological limits of the early days of television and is perceived today as limited in video quality and audio fidelity. It acknowledged that the emergence of several ATV systems places local television service at an historic crossroads. The FCC has specifically asked for public comment on:

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* Notice of Inquiry in MM Docket No. 87-268, FCC 87-246, adopted July 16, 1987, 2 FCC Rcd 5125 (1987), 52 Fed. Reg. 34259 (September 10, 1987).

- The expected development and value of off-air terrestrial advanced television in the United States;
- The features, capabilities and development status of advanced television transmission and reception systems either now under development or whose development is foreseen, and the extent to which these new technologies can be used by other video media;
- The allocation and technical issues that need to be investigated and resolved prior to the use of advanced television systems for television broadcasting;
- The economic, legal and regulatory issues that need to be addressed and resolved prior to implementation of advanced television systems;
- The general timetable for implementation of advanced television systems in broadcasting; and
- The perceived public interest implications for the existing television broadcast service in the United States.

NHK has attempted in these Comments to address certain issues raised by the NOI, although the Comments do not respond to each issue on a point by point basis.

NHK's Comments are from the perspective of a principal developer of a family of advanced television systems. The NHK-developed system most familiar in the United States is a compressed high definition television transmission system. It uses a bandwidth compression format known as MUSE (Multiple Sub-Nyquist Sampling Encoding) which compresses a video signal from 22 MHz to 8.1 MHz, thus allowing satellite transmission. This signal, unfortunately, cannot be received by NTSC receivers currently in use. However,

NHK has developed other systems in its MUSE family which can be received by current NTSC receivers. These systems can serve as a bridge in the transition between NTSC and HDTV (high definition television). The newest additions to the MUSE family, as well as the more familiar HDTV MUSE, will be explained fully in another section of these Comments. It should be stressed that throughout its pioneering efforts in this field, NHK has been most cooperative in sharing its knowledge with others in the United States' ATV development efforts, because it believes that it can make its greatest contribution by making available its technology. NHK plans to make the patents available for use by both domestic and foreign manufacturers in the fairest possible manner.

The Commission has noted three concerns in selecting an ATV system, among which a priority must be established:

- picture quality,
- compatibility with the NTSC format,
- frequency bandwidth.

## II. PICTURE QUALITY IS OF GREATEST IMPORTANCE

Of the criteria to be considered in establishing standards, picture quality must dominate the setting of objectives. Indeed, the quality of picture available to the consumer is the very reason for this Inquiry. This overriding purpose must not be lost in a welter of conflicting

technical parameters. The Commission should make clear that its objective is to achieve the highest possible picture quality and that every effort will be made to overcome any technical and economic impediments.

Both the Commission and Congress have recognized the need for change. The Commission, in its Notice, recognizes that the current system is based upon the technology of 50 years ago and has many technical limitations. NOI, paras. 5-17. Congress, too, has given attention to the availability of new technologies which would bring a dramatic increase in picture quality both for home entertainment and in defense and medical applications. In opening hearings by the House Subcommittee on Telecommunications and Finance, Chairman Edward J. Markey called this development "a watershed for America's telecommunications industries, consumer electronics industry, and most importantly the American television viewer." Opening Statement, October 8, 1987.

From these and other statements it is clear that both Congress and the FCC acknowledge their responsibility to the public to improve television quality.* These statements also embody a political recognition of consumer demand

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* ". . . the government has the responsibility to develop a climate in which this technology can fulfill its promise." Markey Opening Statement.

for such technology gathered from diverse constituencies. There should be no doubt that consumer demand exists for a system vastly superior to NTSC. Consumers have embraced audio compact discs with an enthusiasm far exceeding industry projections. Sales of large-screen television are increasing even in NTSC. Those sales are indicative of a growing demand for large-screen displays which awaits a significant improvement in quality at a reasonable price. As Chairman Markey has noted:

> In just a few short years, television viewers will have in their homes the ability to view a picture on a television screen that compares favorably to a movie theatre. The sound quality will approximate the fidelity of a compact disc player. Movies, sports programming and conventional television will be more striking and realistic than ever before.

## A. THE MUSE HDTV SYSTEM

The one advanced television system which offers viewers the highest picture quality is the NHK MUSE System. In January of this year, NHK performed a terrestrial broadcast experiment in Washington, D.C. of the 1125 line MUSE HDTV system in cooperation with the National Association of Broadcasters (NAB) and Maximum Service Telecasters (MST) using the 12 GHz and UHF frequencies. The joint U.S.-Japan effort gave notice that HDTV has entered an era of practical application in broadcasting. In Japan, all broadcast sys-

tems showing promise for application as ATV have been developed. Two of these systems will soon be available in Japan. High-definition television (HDTV) is expected to be applied in Japan through direct satellite broadcasts within the next three years, while a lesser enhanced definition television (EDTV), which utilizes 525 lines and maintains the 4:3 aspect ratio, will be used in Japanese terrestrial broadcasts within two years. It is expected that the two systems, HDTV and EDTV, will co-exist to prosper in Japan.

1. HDTV Signal Source and Studio Standard

The 1125 line MUSE system signal source will be the HDTV studio standard. This standard has been established through cooperation between Japan, the U.S. and Canada: 1125 scanning lines, 60 Hz, 2:1 interlace scanning, and 16:9 aspect ratio.

The HDTV signal source allows the transmission of five times more data than with conventional (NTSC) television. The signal, when reproduced by the TV receiver, creates picture quality that is equivalent to that of 35mm color film. The HDTV signal source is able to transmit an amount of data per second that is equivalent to 30 A4-sized pages (7-1/16 x 9-13/16 in.) of 10.5 point (2.6mm square)

characters.* Upon close viewing, HDTV exhibits no deterioration in picture quality. This picture quality is equal to or greater than that of 35mm film, providing the viewer with extraordinary realism and a high-level psychovisual effect.

NHK originally proposed a HDTV studio standard of 1125 scanning lines, 60 Hz, 2:1 interlace scanning, and 5:3 aspect ratio. This standard was brought before the Advanced Television Systems Committee (ATSC) and HD Electronic Production Working Group of the SMPTE (Society of Motion Picture and Television Engineers) in the U.S. Together, these groups cooperated in establishing a modified proposal as the HDTV studio standard in the United States. The HDTV aspect ratio was revised from 5:3 to 16:9. The other components of the standard remain the same. This standard was approved by the SMPTE Working Group in August 1987 and the ATSC Committee in September 1987. It is also expected to soon be adopted as the American domestic standard by the American National Standards Institute (ANSI). Canada has also cooperated in the formulation of the standard, and will shortly adopt it as its domestic standard.

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* This is the standard size of paper in Japan and is slightly smaller than the U.S. 8-1/2 x 11 inch standard.

In Japan, the BTA (Broadcasting Technology Association), in August established the HDTV studio standard, making it on a practical basis the de facto domestic national standard. Deliberations are being held in the Ministry of Posts and Telecommunication's advisory council on telecommunication technology for formal approval as the Japanese standard. The resulting standard will be filed with the CCIR (Comite Consultative Internationale de la Radiocommunication, i.e., the International Radio Consultative Committee) in its development of an international HDTV standard.

The HDTV studio standard has already found acceptance in the U.S. film and software production industry. It is being used more and more in productions of feature films and television programming. With quality equal to 35mm film at a reduced cost, greater flexibility for special effects, and editing ease, HDTV will become the primary format for masters. Thus, an increasingly large amount of programming will be available in HDTV form even before consumer display units are available.* It is thus important that this studio standard is adopted for the ATV signal source, permitting broadcasters to take advantage of the standardization of program production facilities.

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* In addition, because of the shared aspect of 35mm film and HDTV, existing programming on 35mm masters may be transferred easily to HDTV for transmission.

## 2. MUSE Transmission System

The MUSE (HDTV) transmission system was developed by NHK originally for satellite broadcasting using frequency modulation. It transmits terrestrially over an 8.1 MHz base-bandwidth signal using VSB-AM (vestigial sideband amplitude modulation) over a 9 MHz channel.

Of the number of ATV systems, only the MUSE system has been tested under actual broadcast conditions. Only the MUSE system is close to production of consumer equipment within the next three years. The system's potential was confirmed in a public test held in Washington, D.C. in January 1987. Satellite transmission tests using the MUSE system were again carried out in October 1987 at the HDTV Colloquium in Canada. It linked cities in the U.S. and Canada, again producing excellent results. In Japan, a series of tests have been carried out since December 1986 using the BS-2 broadcast satellite, demonstrating the viability of HDTV broadcasting. With the launching of the BS-3 satellite in 1990, actual full scale HDTV satellite broadcasts are expected to begin in Japan.

The difference in quality between MUSE and NTSC-related systems is immense. Putting aside the improved aspect of the MUSE picture (more than 1/3 wider than NTSC), the dramatic advance in picture resolution puts MUSE in a

category by itself. The picture quality of a 26-inch NTSC television is not as good as a MUSE picture on a 120-inch screen. Once in full production, the MUSE 40-inch television will cost less than today's price for a 35-inch "large screen" NTSC television. Moreover, the MUSE television set will be capable of receiving not only MUSE signals, but NTSC as well. It will have varied signal sources such as videodisc, tape, satellite transmissions, cable channels, and whatever terrestrial allocation is provided. It is efficient, flexible and of the highest quality.

Production of MUSE receivers is scheduled to begin in 1989. By 1990, 100,000 receivers are expected to be on the market and by 1991 that number will reach 500,000. By 1992 the production of MUSE receivers will be at full capacity. Initial prices for a 30-50 inch MUSE receiver are expected to be $3,000 per set. A MUSE disc player will cost less than $3,000 and a MUSE videotape player will also cost less than $3,000. Both the disc player and the videotape player will be compatible with the MUSE receiver. As production output increases, the costs and, thus the price, of all MUSE components are expected to drop. The consumer will be able to purchase a MUSE system which delivers the highest quality picture technically possible at a price comparable to what an inferior, NTSC-only, large screen system will

cost. It must be remembered that the MUSE system will also be able to receive and play NTSC or other NTSC-compatible broadcasts.

B. OTHER ATV SYSTEMS - THE MUSE FAMILY

1. ADTV

NHK has long proposed adoption of HDTV using the multiple sub-Nyquist sampling encoding (MUSE) technique as the standard for an ATV broadcast system. NHK believes that the Commission should focus its efforts on ensuring that broadcasters have spectrum available to provide MUSE service to the public. Because MUSE is superior in quality to all NTSC-compatible systems, too much focus on NTSC-compatible alternatives may well cause broadcasters to spend considerable funds to upgrade NTSC service and still face a noticeable quality deficit when compared with MUSE service.

Even so, the Commission may wish to consider authorizing an enhancement of NTSC as an interim measure. Should it do so, NHK believes that such an enhanced NTSC system should incorporate MUSE technology and thus be part of the MUSE Family. We would designate this system as Advanced Definition TV (ADTV: MUSE Family). The concept behind ADTV is illustrated in Figure 1. This system has an aspect ratio of 16:9 and is compatible with existing bandwidth limited channels and/or the NTSC system itself.

Use of this system would serve to facilitate a smooth transition to full MUSE because the necessary production equipment is the same for both systems. Therefore, only one capital investment in production facilities would be required for a station studio to become fully operational with first ADTV and then MUSE. This coincides with the Commission's stated inclination toward a TV service integrated with existing television broadcasting which over time would replace entirely the NTSC service. NOI at para. 43. Moreover, this ADTV system can be implemented while deliberations continue in the United States regarding spectrum allocation for HDTV terrestrial transmission.

The aspect ratio of the proposed ADTV format has been expanded to 16:9. This is a complete departure from the current NTSC format and the EDTV format (discussed in the next section). For transmission in 6 MHz and 9 MHz channels, the ADTV system is classified into three types as shown in Figure 1 according to compatibility with the conventional NTSC format.

2. NTSC-MUSE-6

Of the formats shown in Figure 1, the NTSC-MUSE-6 format has the greatest compatibility with the conventional NTSC system. Since it also uses a 6 MHz channel, compatibility with conventional receivers is maintained. Picture

quality, however, is only improved by a single grade (using a seven-grade comparative evaluation standard*) when compared to the current NTSC format. This system's limitations are its reduced picture quality (as compared to HDTV) in order to maintain its compatibility with the NTSC standard.

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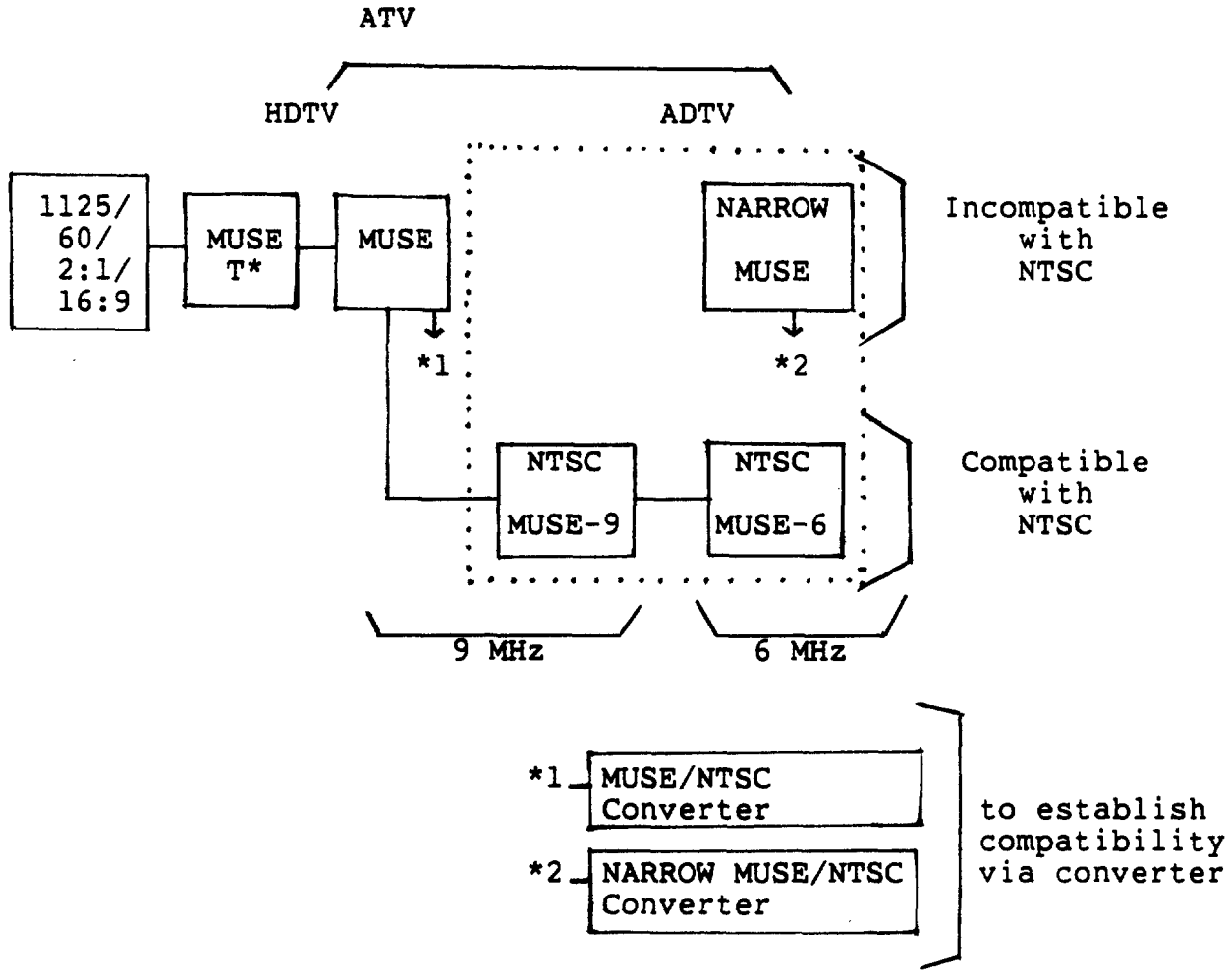
* Comparison Scale authorized by CCIR

| | |
|---|---|
| +3 | Much better |
| +2 | Better |
| +1 | Slightly better |
| 0 | The same |
| -1 | Slightly worse |
| -2 | Worse |
| -3 | Much worse |

Fig. 1 MUSE Family Concept




* MUSE-T Transmission system for program source

### 3. NTSC-MUSE-9

The NTSC-MUSE-9 system also maintains compatibility with the NTSC receiver. But while its transmission bandwidth has been expanded to 9 MHz, the restrictions of the NTSC format prevent it from making full use of the bandwidth expansion. Improvement, as a result, is kept to two grades above the NTSC system, which is the same as that produced in the NARROW-MUSE format.

When the expanded bandwidth portion is not adjacent to the primary channels, the level of improvement of NTSC-MUSE-9 drops to a grade of 1.5 because the difference between the transmission and reception characteristics of the two channels causes ghosting, lowering the ADTV picture quality. Not only is there a decline in the spectrum utilization factor, but there also is the added disadvantage of requiring multiple demodulators. This system is compatible with the NTSC-MUSE-6 format.

### 4. NARROW-MUSE

The NARROW-MUSE format uses a 6 MHz channel, but is not compatible with the NTSC format. Since it is not bound by the restrictions of the NTSC format, it produces an improvement of two grades compared with the NTSC system.

C. EDTV SYSTEMS

An EDTV system can be thought of as being an extension of the conventional NTSC system, retaining the 4:3 aspect ratio. As a result, it should not be considered as belonging to the same category as ADTV. BTA has been the leader in Japan in EDTV development. NHK has also contributed greatly in EDTV development. This system combines several techniques to improve the defects inherent in the NTSC system, such as color and brightness separation and scanning method.

D. COMPARISON OF ATV SYSTEMS

A comparison of picture quality of the HDTV, ADTV and the standard NTSC systems is shown in Figure 2. In addition, Table 1 gives a shorthand highlight of the technical differences of the four systems. From the comparison of picture quality of MUSE and ADTV, NARROW MUSE can be said to be quasi-HDTV. NTSC MUSE-6 and MUSE-9 have compatibility with NTSC but are inferior to HDTV by 1.5 grades. Adoption of these systems on a long-term basis would be ill-advised.

Fig. 2 Comparison of Picture Quality
between ATV and NTSC system

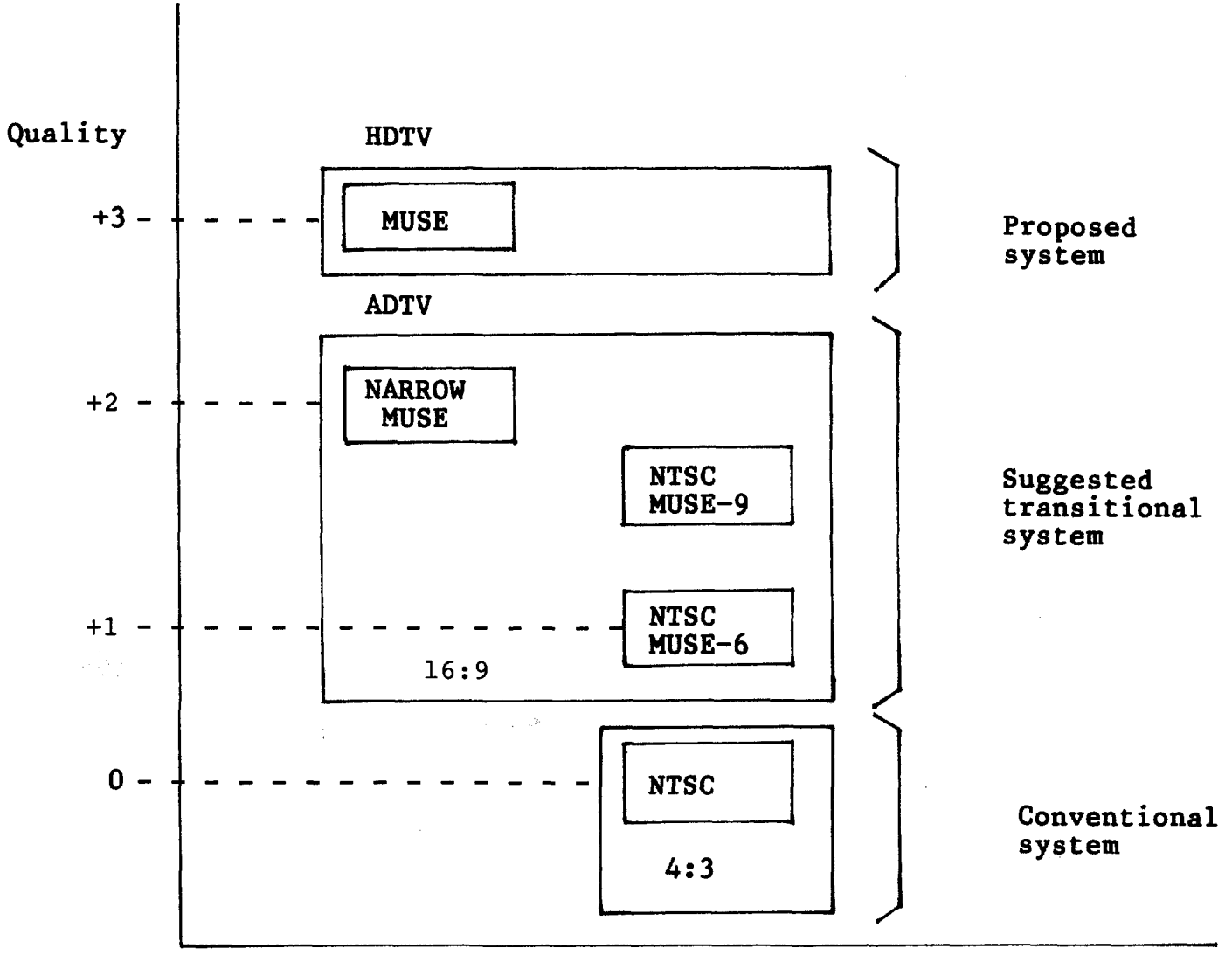


Table 1

ATV TECHNICAL COMPARISON

| Format | |
|---|---|
| MUSE: | Developed by NHK for use with satellite transmission. Compresses the base-bandwidth to 8.1 MHz using multiple sub-sampling. This is transmitted on a 9 MHz contiguous channel using VSB-AM. Incompatible with the NTSC format. |
| NARROW-MUSE: | A reduced version of the MUSE format using identical bandwidth compression algorithms. Base-bandwidth is compressed to 5 MHz. Incompatible with the NTSC format. |
| NTSC MUSE-6: | Maintains compatibility with the NTSC format. Picture quality improvement is done using the 6 MHz transmission bandwidth, and the high-resolution data is inserted into the 4.2 MHz base-bandwidth using the same MUSE compression techniques. |
| NTSC MUSE-9: | Maintains compatibility with both the NTSC and NTSC MUSE-6 formats. Additional data for improving picture quality is transmitted on an extra 3 MHz bandwidth. The MUSE bandwidth compression technique is used in the transmission of the additional data. |

## III. COMPATIBILITY

As noted above, the MUSE and NTSC formats are not compatible. However, the MUSE receiver will receive signals in both formats, and existing NTSC receivers could accept MUSE transmissions by adding a small low-cost converter. The converter, costing less than $50.00, offers the most practical means of attaining compatibility for the consumer, despite incompatible systems.

It must be recognized that pursuit of a single system compatible with the conventional NTSC receivers now in use results not only in lower picture quality improvement, but also increases the complexity of the transmission system and the receiver, not to mention increasing significantly its cost. In addition, brightness and color separation of the NTSC system is fundamentally flawed, limiting picture quality improvement in all ATV systems maintaining compatibility with the NTSC format. Thus, picture quality improvement will always be greatest in systems relinquishing NTSC compatibility.

Again, should the Commission wish to authorize an NTSC-compatible system, the system should be one such as ADTV which can ease the transition to full MUSE. ADTV can be employed while there are still restrictions on transmission bandwidth. After resolution of spectrum

allocation questions, only the encoder, transmitter and transmission lines will have to be changed as the switch-over from ADTV to HDTV takes place. This will cut unnecessary investment outlays for broadcast studio facilities and prevent multiple receiver costs for consumers.

## IV. SPECTRUM ALLOCATION

The greatest difference between spectrum allocation for ATV in Japan and the United States is the allocation of UHF channels. In 1952 in the United States, a set of "UHF taboos" were formulated based on the performance characteristics of the television receivers at that time. This decision stipulated that a maximum of nine channels out of the 55 UHF channels could be used in any single region, leaving a large number of unused channels in the UHF bandwidth.

In Japan, on the other hand, UHF channel distribution was carried out for the first time in 1967 based on the standard performance characteristics of the television receivers then. Since that time minor revisions have been made, and all channels in the UHF band have been distributed for broadcast use leaving absolutely no open channels at present.